The Trichoptera of the Sundays and Fish Rivers, Eastern Cape Province, South Africa

by

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ABSTRACT

The impoverished Trichoptera faunas of the Sundays and Fish rivers (Eastern Cape Province, South Africa) are described and discussed in relation to the harsh environment and climatic conditions prevailing in the area. This work formed part of the Orange River Project, with particular relevance to the effects of the future inflow of Orange River water into these two rivers, which at present are highly mineralized and largely or entirely seasonal.

INTRODUCTION

The work described in this paper formed part of several more general surveys of the Sundays and Fish rivers, and was carried out under the auspices of the Orange River Project (see Forbes 1968, Forbes & Allanson 1970a & b, Scott, Allanson & Chutter 1972).

Its aims were, firstly, to determine the present Trichoptera (caddisfly) faunas of the Sundays and Fish rivers, and to establish whether or not there are any differences between them. Secondly, it was hoped to gauge the effects of brackish water and exposure to alternate droughts and floods upon the Trichoptera, since both these rivers are subject to such phenomena. In this they are typical of the greater part of the Eastern Cape Province.

At present both rivers only flow intermittently after rain, excepting for that part of the Sundays which lies between Kirkwood and the sea (see Fig. 1), where there is a very small permanent flow. Once the first stage of the Orange River Development Scheme has been completed, some 1 460 cusecs (41,3 cumec) of water are scheduled to flow through the tunnel from the Hendrik Verwoerd Dam into the Fish and Sundays rivers, providing much-needed water for their irrigation schemes and enabling these to be expanded. This inflow of water should change both rivers below the intake to perennial rivers, though the quality of the water flowing through them will depend to a large extent upon the way in which the irrigation water is distributed.

The Orange River water is likely also to bring with it members of its own fauna and flora, including Trichoptera, and it is expected that this investigation will be continued at a later date to discover what changes in the Trichoptera fauna have been brought about both by the influx of other species and by the changes in water quality.

The survey was commenced in August 1967 and ended in March 1970, during most of which period there was a severe drought. Shortly after the termination of the work the drought was broken by heavy rains which caused floods in the Fish River. The Sundays received less rain at that time, but a year later, in August 1971, catastrophic floods occurred in the Sundays, Fish, Gamtoos and Swartkops rivers, during which much scouring of the river beds took place

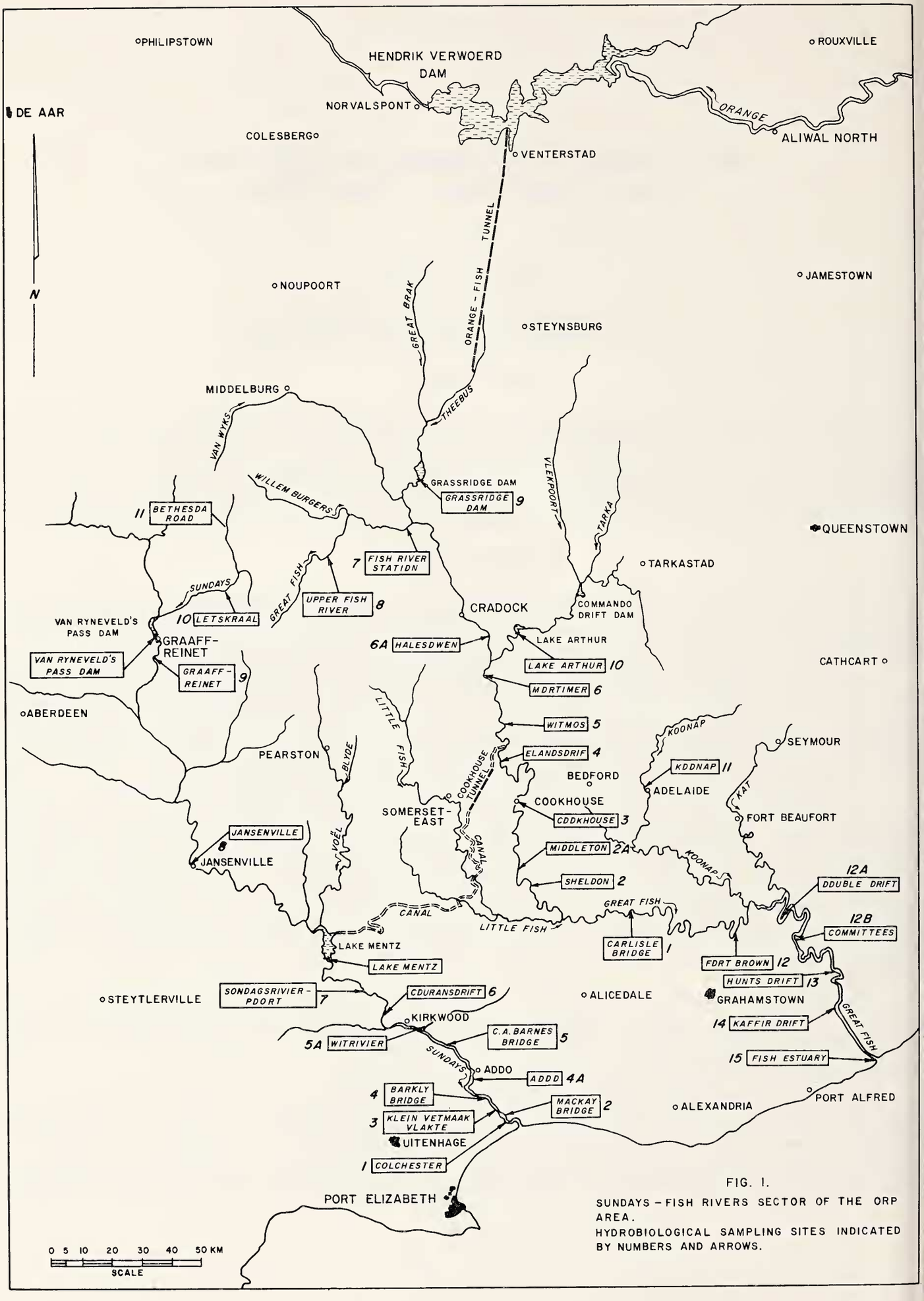


FIG. 1.

SUNDAYS – FISH RIVERS SECTOR OF THE ORP AREA.
HYDROBIOLOGICAL SAMPLING SITES INDICATED BY NUMBERS AND ARROWS.

and adjacent lands were deeply inundated. Later visits were therefore paid to the Sundays River in October and November of that year to evaluate the effects of the floods on the Trichoptera population.

GENERAL DESCRIPTION OF THE SUNDAYS AND FISH RIVERS

The Sundays and Fish rivers lie in adjacent catchments in the Eastern Cape, in an area bounded to the north by an escarpment formed from soft sedimentary rocks of the Karoo System. Much of the coastal plain and other mountain ranges involved is composed of the same soft rocks. Both rivers enter the ocean to the east of Port Elizabeth (see Figs. 1 & 2). Both catchments lie in the rain shadow of the coastal ranges and are therefore arid with low precipitation (125–500 mm per annum) and very high evaporation rates (1 250–2 000 mm p.a.). In addition, the rainfall is seasonal, with long rainless periods even when there is no drought. As a result of these factors the upper reaches of the Sundays and Fish and their tributaries seldom flow except in spate after heavy rain or snow, and when they do their waters are heavily laden with silt. Several irrigation dams have been built on their courses, and these tend to trap much of the silt, so that at times of low flow the river water may be clear.

Most of the underlying rock formations are salt-bearing to a greater or less degree, producing brackish or saline ground waters, which together with the arid climate, result in correspondingly brackish river waters, which are further mineralized by irrigation water draining from adjacent farm lands. The waters of the entire Fish River, and of the Sundays as far down as Kirkwood, are brackish but potable; the lower reaches of the Sundays below Kirkwood, however, flow over marine beds, becoming increasingly saline and finally unusable for domestic or farming purposes. The geology and geography of this area and the physico-chemical condition of these rivers have been described in various papers (see Bond 1946, Forbes 1968, Forbes & Allanson 1970a, Scott *et al.* 1972), to which reference should be made for further information.

The collecting stations used are shown in Figures 1 and 2, and briefly described in Appendix I; months in which collecting trips were made are given in Appendix II. Many of those expeditions were fruitless, as has been indicated in the text.

THE TRICHOPTERA POPULATION OF THE SUNDAYS RIVER (1967–70)

DISTRIBUTION OF THE TRICHOPTERA

In the upper part of the catchment, above Lake Mentz, it was evident that the streams were too ephemeral and the country too arid for Trichoptera to survive, the only ones found being a few Hydroptilidae at Station 10, where there was water from apparently permanent springs. Even there they were not common and were found only once, in February 1968. The major obstacle faced at Station 10 was probably that of isolation from any better populated water body, because temporary waters in the northern hemisphere usually support large populations of Trichoptera. Those lie, however, in much better watered country, so that dispersal is easy.

There was also permanent water at Station 9, immediately below the town of Graaff-Reinet, but during the drought years this appeared to consist mainly of sewage effluent and no Trichoptera were found in it, although it supported a fair population of more tolerant insects such as Hemiptera, Ephemeroptera, Odonata and Coleoptera.

The water level in Lake Mentz was very low during the early part of the study period, and the lake dried up completely in February 1968; no Trichoptera were found there at any time.

Below Lake Mentz, at Stations 7 and 6, a few Trichoptera were collected in 1967 but

TABLE 1. WATER ANALYSES: SUNDAYS RIVER (From Forbes 1968)
Except for pH and bottom line, all values are in mg/ℓ.

Stations	3	** 4A	4A seepage	5			5 seepage	5A (Wit)	6		7		** 10
Date	Feb.* 1967	Nov. 1967	Nov. 1967	Feb.* 1967	July* 1967	Feb.* 1968	July 1967	Feb. 1968	Feb.* 1967	July* 1967	Feb.* 1967	July* 1967	July 1967
pH	8,5	8,9	7,5	9,1	8,8	9,1	—	7,8	8,4	8,8	8,5	8,6	8,4
Oxygen	4,8	8,8	7,2	8,2	8,0	—	—	—	8,2	8,6	6,8	8,9	6,1
TDS	25 224	5 534	25 910	4 349	1 836	4 600	7 585	286	918	998	909	1 027	614
Carbonate	57	36	0	74	6	120	0	0	3,6	0	2	0	6
Bicarbonate	263	342	256	312	189	305	598	37	111	122	95	110	177
Calcium	123	59	381	15	53	21	118	1,5	54	56	39	56	58
Magnesium	657	202	1 220	159	71	165	195	19	39	33	36	46	50
Potassium	106	7,9	43	8,8	2,8	12	9,1	4,9	10	4	11	4,4	1,8
Sodium	5 500	1 400	6 700	1 400	600	1 480	2 630	69	290	210	270	275	111
Sulphate	1 150	1 075	2 591	670	305	749	1 482	20	130	330	145	182	157
Nitrate	—	1 ,36	18,7	0,97	2,13	—	45,22	—	0,88	0,12	0,18	<0,02	0,6
Phosphate	0,08	0,01	0,01	0,01	0,04	—	0,02	—	0,01	0,01	0,01	<0,01	0,05
Chloride	8 260	2 109	11 358	1 710	609	1 748	2 553	119	280	243	310	354	46
Chloride expressed as % of TDS	51,2	40,3	50,0	39,3	32,9	37,9	33,7	44,0	30,3	24,3	34,1	34,3	7,4
TDS values: May 1970**	44 800	12 370	21 832	5 403			3 864	—	815		—		—

* Trichoptera were collected from these stations on these dates. In the case of station 3, however, the single larva caught was undoubtedly drift.

** Trichoptera were taken at these stations, but not on the same date as the chemical sample.

none subsequently, as water in those stony runs was dependent on irrigation flows, which ceased early in 1968. Those found were larvae of *Cheumatopsyche afra* (Mosely) and *Ecnomus thomasseti* Mosely.

Stations 6, 5, 4A and 4 lay on the lower course of the river where the water became very saline, the TDS (total dissolved solids) values from samples taken ranging between 800 and 1 000 mg/ℓ at Station 6, 1 800 to 4 600 mg/ℓ at Station 5, and 5 500 to 9 300 mg/ℓ at Station 4A during the earlier part of the survey (Forbes 1968). Supplementary analyses made in May 1970 gave TDS values of 815 mg/ℓ at Station 6, 5 403 at Station 5 and 12 370 at Station 4A (Scott *et al.* 1972) (see table 1).

Station 5 was the uppermost sampling point at which permanent water was present, and the only one which appeared to remain habitable by Trichoptera throughout the period. Caddisflies evidently persisted there as a small resident population even though they could not always be found when samples were taken; this might well have been due, in part at least, to emergence of imagos, but the mineralization of the water could also have been implicated, as, for example, in March 1970 when none was found and flow in the river was almost non-existent. Unfortunately no chemical analyses were carried out at that time, but two months later, in May 1970, TDS values had risen sharply to 5 403 mg/ℓ, some 800 mg/ℓ higher than the highest value at which healthy living Trichoptera were found at any station on the Sundays or Fish rivers.

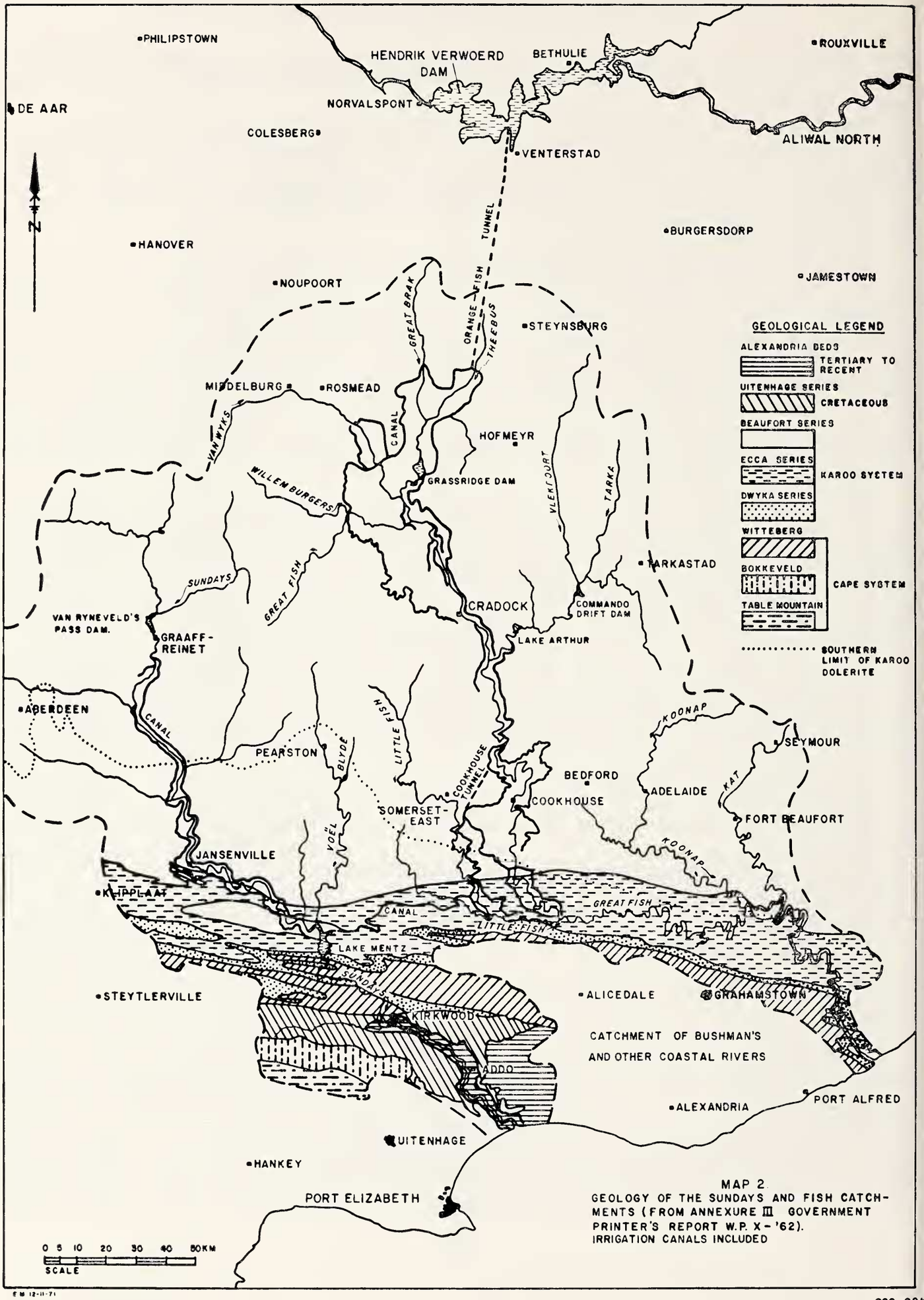
The Trichoptera at Station 5 included four species, of which *Ecnomus thomasseti* was present in fair numbers in the years 1967 to 1969, numbers being higher in summer (February) than in mid-winter (July); in late winter (August) none was found. Numbers dropped considerably in 1969 and the species was not encountered subsequently. *E. forbesi* Scott, a new species described from this river (Scott 1968) was rare, only one male being found at this station in August 1967. *Cheumatopsyche afra* was also present in moderate numbers in the years 1967 to 1969; it too was more plentiful in summer than in winter.

The next station downstream, 4A, produced a very small collection of Trichoptera in the winter of 1967, comprising a single male of the new species, *E. forbesi*, and two *Ecnomus* larvae, probably of the same species, and a single larva of *C. afra*. Thereafter conditions rapidly worsened as the drought continued, and no more caddis were found. At the stations below 4A TDS values rose steeply, and the sole caddis larva found lower down, at Station 3 (upper estuary), was undoubtedly drift.

The more obvious reasons for the limitation of any sizeable population of Trichoptera to the vicinity of Station 5 seem to be twofold. In the upper reaches, in fact above Station 5, the primary reason appears to be the transitory flow of the water, due in part to the drought and in part to the farming methods practised and abstraction of water for irrigation. In the lower reaches, the very high TDS values (arising from the geology and aridity of the area but intensified locally by the irrigation of citrus orchards) are evidently the limiting factors.

Even at Station 5 itself, it is possible that the water might have been too highly mineralized to support a population of Trichoptera had it not been for the seasonal inflow of sweet water from the Witrivier tributary shortly above it. No Trichoptera were, however, found in the lower part of the Wit (Station 5A), probably due to its ephemeral nature. Its upper reaches in the Suurberg mountains were somewhat inaccessible and were not visited.

When apparent disappearance of the population took place, survival may have been by means of diapausing eggs, or diapausing larvae, or recolonisation may have taken place from elsewhere, the only possible source being the upper reaches of the Wit. There is at presence no evidence as to which of these might be concerned. In the few Trichoptera from cold or temperate climates so far studied, diapause occurs in late instar larvae (Hynes 1970). Hynes also found that many insect larvae, including some Trichoptera, take refuge in the substratum, down to depths of several feet. In the Sundays River, however, there are no



MAP 2.
GEOLOGY OF THE SUNDAYS AND FISH CATCHMENTS (FROM ANNEXURE III GOVERNMENT PRINTER'S REPORT W.P. X - '62).
IRRIGATION CANALS INCLUDED

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depths of gravelly well-aerated substrata, spaces between stones frequently being clogged with sand or mud which may be anaerobic a few centimetres below the surface. Harrison (1966) on the other hand, working on the recovery of Rhodesian streams treated with molluscicides, found that in the case of *Cheumatopsyche* species re-invasion by adults from neighbouring streams took place; he found no evidence of diapausing eggs.

SPECIES COMPOSITION OF THE POPULATION

The Trichoptera of the Sundays River comprised only four species in three genera, of which one, the Hydroptilid *Hydroptila* sp., was only found alive at Station 10, and another, *Ecnomus forbesi*, was rare. The other two species, *Ecnomus thomasseti* and *Cheumatopsyche afra*, both occurred at Station 5 in moderate numbers, and were evidently able to grow well and reproduce even at relatively high TDS values (up to 4 600 mg/ℓ TDS, 1 480 mg/ℓ Na and 1 748 mg/ℓ chloride). Both are eurytopic species which have been recorded from very diverse habitats in both alkaline and acid rivers in Southern Africa. *E. thomasseti* has been recorded from the Western Cape Province to South West Africa and Rhodesia, and *C. afra* from the Western Cape through to Ethiopia in the east and Sierra Leone in the West. *C. afra* is, however, variable, and may eventually prove to include a complex of closely related species.

The Hydroptilid found was a species of *Hydroptila* whose larva makes a purse-like case ornamented with algal threads. Two South African species are known to do so, *H. capensis* Barnard and *H. cruciata* Ulmer, but at present it is impossible to distinguish between their larvae.

It might have been expected that the low water levels and minimal currents of summer would affect *Cheumatopsyche afra* adversely, as Hydropsychid larvae tend to prefer areas of rapid water movement where they spin their nets in the current. This did not, however, appear to be the case, though numbers were never high. *Ecnomus* species (family Psychomyiidae) were usually found out of the main current under stones or in vegetation. All Trichoptera collected were normal and healthy in appearance.

THE TRICHOPTERA POPULATION OF THE FISH RIVER (1964—1970)

The Trichoptera collected in the Fish River included *Cheumatopsyche thomasseti* Ulmer, *Ecnomus thomasseti* and a single larva of a species of *Cheumatopsyche* near *maculata*. (*C. maculata* Mosely occurs fairly frequently in some of the other streams in this region.) Only the first of these was found in any quantity. *C. thomasseti* larvae were numerous at times at Stations 3, 4 and 5 early on in the survey, much less so at Stations 1, 2, 6, 7 and 12. Later, as the drought increased in severity and the river dried up, they disappeared except at Station 6, at which they were still present in August 1969. A few *Hydroptila* sp. larvae, similar to those found at Letskraal on the Sundays River, were collected at Station 3 on the Fish, also in February 1968, as were a few *E. thomasseti*, but no caddis were found there subsequently.

As was the case in the Sundays River, these Trichoptera proved able to survive under remarkably poor conditions, living caddis larvae being found in water with TDS values ranging from 511 mg/ℓ (Station 9) to 3 368 mg/ℓ (Station 3), and calcium values ranging from 27,7 mg/ℓ (Station 9) to 115 mg/ℓ (Station 4). Calcium values have been particularly mentioned because Trichoptera larvae from all the Fish River stations except 1 and 10 were more or less heavily encrusted with a white casing of calcium carbonate; the Carlisle Bridge and Lake Arthur specimens were only lightly powdered with it. Larvae found at Stations 3, 4 and 5 were particularly badly affected, often with head and eyes completely covered and gills matted with calcareous material. Trichoptera were abundant at the time, and most were heavily coated, only a few showing little or no trace of the deposit. Ca values when the collections were made ranged from 89—115 mg/ℓ.

TABLE 2. WATER ANALYSES: FISH RIVER (Allanson: pers. comm.)
Except for pH and temperature, values are in mg/ℓ.

Stations	2	3		4		5		6	9	10	12
Date	July* 1964	July* 1964	Feb.* 1965	July* 1964	Feb.* 1965	July* 1964	Feb.* 1965	July* 1964	July* 1964	July* 1964	Feb.* 1965
Temperature °C.	—	11,5	24,0	13,5	26,3	10,5	27,0	7,5	—	4,5	22,0
pH (field)	—	8,4	8,3	8,5	8,4	8,4	8,6	8,5	9,0	8,8	8,8
TDS	3 311	3 368	—	2 717	2 857	3 029	3 038	2 906	511	877	—
Ca	80,1	103,7	—	89,3	115	58,5	102	47,2	27,7	46,8	—
Na	810	655	—	580	445	830	735	810	110	230	—
K	7,3	6,8	—	5,6	7,5	5,6	8,5	3,8	3,3	3,5	—

* Trichoptera were collected from these stations on these dates.

It is known that waters that emerge from the earth highly charged with calcium bicarbonate and flow away as streams may deposit calcium carbonate on the substratum (Macan 1963). In the Fish River such deposition can evidently also take place on some of the animals. The most important anions in the upper reaches and some other parts of the Fish and Sundays rivers were bicarbonates (Scott *et al.* 1972), which in the Sundays River ranged from 32,6% of the TDS in the upper reaches to 7,4% in the lower. In the Fish River the bicarbonate values were higher, ranging from 58,0% of the TDS in the upper reaches, through 20% to 12% in the middle reaches, and rising again to 41% in the lower. The crusts of lime occurred mainly on the dorsal side of the larvae, and were so thick that the animals must have been seriously hampered in collecting food. When the $CaCO_3$ was dissolved with dilute HCl a layer of organic material remained on which it appeared to have been deposited. This consisted of "aufwuchs", mainly filamentous algae and diatoms, and detritus. Such a "fur" of aufwuchs is characteristic of *Cheumatopsyche thomasseti* larvae, and makes a conspicuous covering on the dorsal side of the head, though not necessarily confined to that site.

A search for Trichoptera was also made along the margin of the irrigation dams, Lake Arthur and Grassridge, and their outflows. None was found in the dams themselves, which was not surprising. Alkaline standing waters in Southern Africa not only tend to have a poor Trichoptera fauna (Scott 1970), but in these irrigation dams the water is heavily silt-laden, the water levels fluctuate greatly, aquatic macrophytes are absent and the water may dry up completely. A single caddis larva was found in the stream of seepage water flowing from the base of Grassridge Dam (*Cheumatopsyche* sp.), and a large number of *C. thomasseti* larvae and an *Ecnomus* larva in the outflow from Lake Arthur, in a stony run. These were found in 1964. Subsequently, owing to the drought, Grassridge Dam dried out completely and Lake Arthur nearly so.

EFFECTS OF THE 1971 FLOOD ON THE SUNDAYS RIVER

Over the weekend of 20—22 August 1971, torrential rains fell in the catchments of the Sundays and other East Cape rivers. Lake Mentz, which had only been about 28% full before the rain commenced, was overflowing to a height of more than 1,5 m above the top of the dam wall less than 24 hours later, and the Sundays had become a turbulent mass of water up to 2 km wide, flooding lands and houses, uprooting orchards and washing away or breaching bridges.

Although it is recognized that flooding normally only reduces the abundance and variety of the fauna (Hynes 1970), in view of the known paucity of the fauna in the Sundays it appeared very possible that those Trichoptera that had survived the drought might well have been washed away in the floods. Two visits were therefore paid to the Sundays River, a month and two months after the flood waters had subsided, in order to assess the situation.

On 12 October 1971, Lake Mentz was still overflowing at the level of the flood gates. Station 7 could not be visited as the road to it had been washed away. From Station 6 downstream the river bed had been much scoured out, and the vegetation-covered banks, weedy pools and shallow stony runs replaced by heaps of clean-washed river stones littered with storm debris and a deep, swiftly flowing stream. At Station 5 the submerged stones were thickly coated with innumerable *Simulium* larvae, which are extremely successful, early invaders of any such habitat. On turning over the more accessible submerged stones a number of caddis larvae were found, one or two to every fifth or sixth stone picked up, and a few pupae. Two imagos (1 ♂, 1 ♀) were found on the causeway. All proved to be *Cheumatopsyche afra*.

On 10 November 1971, Station 5 was visited again. The river was lower and flowing more slowly, but still deep and fairly swift. The *Simulium* larvae were still extremely numerous and pupating, and *Simulium* adults present in clouds. The caddis larvae were somewhat more

plentiful under the stones and were also pupating; two imagos were again caught on the causeway (no marginal vegetation present). All were *C. afra*. Other aquatic insects, mainly Dytiscid beetle larvae and mayfly nymphs (*Cloeon* sp.) had appeared. Examination of gut contents of the caddis larvae showed that they were preying on *Simulium* and other insect larvae.

DISCUSSION

These are the first records of South African Trichoptera found living at TDS levels of this order of magnitude. Sutcliffe (1962a & b) has, however, recorded *Limnephilus* and *Anabolia* larvae (Trichoptera, Limnephilidae) with similar, and in one species, considerably greater, degrees of tolerance. Larvae of *L. affinis* occur in both fresh and brackish water environments as well as in salt marsh pools, and Sutcliffe showed experimentally that these larvae are able to live in 50% seawater, and to tolerate up to 75% seawater for quite long periods (50% seawater has a TDS of about 17 500 mg/ℓ and 75% of about 26 000 mg/ℓ). *L. stigma* and *A. nervosa* are freshwater caddis not found in salt marshes, and are only able to tolerate up to 10% seawater (TDS about 3 500 mg/ℓ), which approximates to the level of tolerance in the caddis species found in the Fish and Sundays rivers.

The family Limnephilidae is not represented in Africa south of the Sahara. It appears that in *L. affinis* hyporegulation is achieved by controlled drinking of the medium and excreting the excess salts in the rectal fluid.

In comparison with these Trichoptera species from the Sundays River, Forbes and Allanson (1970b) showed that amongst the Ephemeroptera species found there, *Cloeon crassi* could live at TDS levels from 7 000 mg/ℓ to 10 500 mg/ℓ, younger nymphs being more sensitive than older ones. In *Centroptilum excisum* the salinity tolerance was somewhat lower, the highest TDS values tolerated lying between 3 500 and 7 000 mg/ℓ.

CONCLUSIONS

Several interesting facts have emerged from this work on the Sundays and Fish rivers.

Firstly, the impoverishment of the Trichoptera fauna of these two rivers is undoubtedly related both to the poor quality of the water, which derives from the geology of the area, intensified by the arid climate and the farming methods employed, and to its largely temporary nature. Nevertheless it was very interesting to find what unexpectedly high TDS levels and related chemical factors those few species that do occur in these rivers can withstand, in addition to alternations between drought and flood, and the silt load carried by the flood waters. The abrasive action of sand and silt and the fluctuations in water level appear to be the most important factors in the reduction of stream populations by floods (Hynes 1970). TDS values did not rise quite as high in the Fish River as in the Sundays (cf tables 1 & 2), in which the Trichoptera were virtually limited to Station 5 by the chemical condition of the water farther downstream and its ephemeral nature higher up.

Both these rivers are mainly lowland rivers in type, and their poor Trichoptera fauna probably reflects conditions obtaining in much of the East Cape where the water is brackish, usually temporary, and often silty. The few very small permanent streams found in the highlands near Grahamstown are clear, their water slightly acid to neutral, and they have a very different, though also somewhat restricted, Trichoptera fauna, as have the larger permanent streams on, for example the Hogsback and Amatola mountains farther to the north and east. I hope to describe the former in the near future.

Also of interest is the fact that different species of *Cheumatopsyche* occur in the two rivers in spite of the many similarities between them and the close proximity of their upper catchments. The reasons for this difference are not fully known, though Chutter (1969) in

his study of the Vaal River has suggested that the differences in relative abundance of the two species *C. afra* and *C. thomasseti* in different parts of the same river may be correlated with the amounts of silt and sand present in river bed and water. He found that in the Vaal River *C. afra* usually occurred in larger numbers in the eroding zone, where there was little deposition, while *C. thomasseti* was the more abundant in the two zones in which large amounts of silt and sand settled at certain times of year. Similarly, in the Berg River in the West Cape, *C. afra* tended to occur higher up, in the eroding zone, while *thomasseti* was the commoner in the more silty lower reaches. Although silt deposition was not a problem in the Fish River during the survey owing to the low flow, it certainly proved to be so in the floods of 1970 and 1971. Another possibility is that both species formerly occurred in both rivers when the water was more permanent, and that the present stringent conditions have eliminated one species in each.

After the 1971 floods it was noticeable at Station 5 on the Sundays River that the Trichoptera were the earliest group to follow the Simuliidae, on which they were preying. It is known that Simuliidae and Hydropsychid Trichoptera (such as *Cheumatopsyche* species) do not usually co-exist as large populations. The Simuliidae tend to appear in large numbers first as they recolonise more rapidly than the Trichoptera, to be replaced later in some instances by Hydropsychidae. This could well be a predation effect, in part at least, both on the part of the Hydropsychid larvae and on the part of the *Simulium* larvae themselves. Other factors are certainly also involved, for an initially large number of Simuliidae is by no means invariably followed by large numbers of Hydropsychidae. It will be interesting to see what happens when the Orange River water comes through, as there often seems to be some sort of balance between these two groups of insects.

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APPENDIX I

COLLECTING STATIONS ON THE SUNDAYS AND FISH RIVERS

The stations used in searching for Trichoptera were those used during the river surveys, from the accounts of which further details may be obtained (see Forbes 1968, Forbes & Allanson 1970a, Scott *et al.* 1972). All stations are indicated by numbers in Figures 1 & 2 ,but as Trichoptera were only found at certain of them, only those are named in Figure 1 and described briefly below.

A. SUNDAYS RIVER

4A. ADDO: just above the Port Elizabeth—Addo road bridge; long, sandy pools linked by shallow stony runs, fringed by reeds, with beds of *Ruppia* (Potamogetonaceae) in the pools. TDS levels were always high, and were further raised by the highly saline seepage from the banks and by the drought, by the end of which flow had almost ceased and salt was crystallizing out on stones and margins.

5. C. A. BARNES BRIDGE: an old causeway below the C.A. Barnes Bridge across the Sundays on the Addo—Kirkwood road; bed wide and stony, with deeper pools and more luxuriant vegetation (mainly *Cyperus* and grasses) than at 4A; some Potamogetonaceae in the pools. By late summer there was scarcely any flow, the water became very green and the stones in the runs encrusted with Cyanophyceae and soft calcareous material. TDS levels were high, but lower than at 4A (see table 1). Seepage from the banks was strongly saline.

5A. WITRIVIER TRIBUTARY: this enters the Sundays just below Kirkwood. It is a seasonal stream with sweet water, coming from the Suurberg mountains, and at Station 5A it comprised a large pool with a rich growth of aquatic plants (*Limnanthemum*, *Aponogeton*, *Nymphaea*, *Potamogeton*, *Polygonum*), below this a drift, then a shallow stony run and a lower pool. Both the latter were green with algae and showed traces of pollution from clothes washing. Although no Trichoptera were found in the Witrivier, it has been included as its waters strongly influence the water at Station 5 while it flows.

6. COURANS DRIFT: small stony run linking a large grass-banked seepage pool below an irrigation weir with the river bed. As amount of water was dependent on irrigation turns, flow was very variable and ceased completely during the drought.

7. SONDAGSRIVIERPOORT: stony run in mountains above Courans Drift. There the river bed, containing large pools linked by shallow stony runs, was used as an irrigation channel linking Lake Mentz with the Courans Drift weir. Flow very variable, ceasing when Lake Mentz dried up in February 1968.

10. LETSKRAAL: in mountains above van Ryneveld's Pass Dam, just below the Letskraal Trading Station, on farm Glen Harry; small permanent pools below cliffs. Rest of river bed flood-scoured and dry except after heavy rain. Water in pools clear, flow visible even when partially silted up at times; a rich aquatic and semi-aquatic vegetation of *Ranunculus*, *Scirpus*, *Cotula* and algae.

B. FISH RIVER

1. CARLISLE BRIDGE: on the road between Grahamstown and Bedford. Sandy bed with large pools and a few stones; water discontinuous or absent during most of the period of the survey.

2. SHELDON: some distance farther upstream, above the confluence with the Little Fish River; as Station 1.

3. COOKHOUSE: a small local flow of muddy, greenish, polluted water, mainly or entirely sewage effluent from the town of Cookhouse except after rain.

4. ELANDSDRIF: near the viaducts on the railway lines; similar to Station 1.

5. WITMOS: unpolluted seasonal flow over stones and sand near the farm Witmos.

6. MORTIMER: a small clear, seasonal flow over sand and stones just below the village of that name.

9. GRASSRIDGE DAM: on the Theebus River tributary; a large shallow dam with silt-laden water and solid clay banks. Below wall a stream of seepage water flowed through reeds and over a stony run; one caddis larva collected in run. Dam fairly full in 1964 but dried up completely by the end of 1969.

10. LAKE ARTHUR: on the Tarka River tributary; large dam with silt-laden water and rocky or stony shores. Below wall clear water from the sluices, added to by seepage, formed a stream in which Trichoptera larvae were found in 1964 when the dam was fairly full. Lake Arthur dried up almost completely towards end of drought.

12. FORT BROWN: Fish River at Fort Brown, downstream of Station 1. Discontinuous pools during part of survey but completely dry at times.

APPENDIX II

COLLECTING TRIPS MADE ROUND THE SUNDAYS AND FISH RIVERS

A. SUNDAYS RIVER

The earliest collecting trips in 1967 were made by Forbes (Forbes 1968, Forbes & Allanson 1970a), later ones by the author. In all, six collecting trips were made round the entire catchment: in February and July 1967, February and August 1968 and February and August 1969. Station 4A was not included in February 1967. Additional visits were paid to Stations 4A and 5 in August 1967, July 1968 and March 1970. Chemical analyses of the water from some of the stations were made by Archibald in May 1970, the rest of the analyses were done by Forbes. Station 5 was revisited after the floods of August 1971, in October and November of that year.

B. FISH RIVER

The two earliest trips round the catchment of the Fish River were made by Professor Allanson and a team from the Institute for Freshwater Studies, Rhodes University, in July 1964 and February 1965, on which occasions chemical analyses of the water were also made. Subsequent trips round the main catchment were made by the author in February and August in both 1968 and 1969, including the lower reaches (Stations 12A—14) in February 1969. Station 13 was visited again in March 1970, at which time Station 12 was completely dry.